Journal of Pioneering Medical Sciences
Received: March 14, 2025 | Accepted: April 16, 2025 | Published: August 05, 2025
Volume 14, Issue 07, Pages 159-165

DOI https://doi.org/10.47310/jpms2025140725

Environmental Health Measures in Healthcare Facilities: A Comparative Review of Policies in Saudi Arabia and Global Standards

Ali M. Alshehri[1*], Mohamed Osman Elamin[2] and Ahmed A. Osman[3]
[1,2]Department of Environmental and Occupational Health, Faculty of Public Health and Informatics, Umm Al-Qura University, Kingdom of Saudi Arabia
[3]Independent Scholar, Chrestfield, United Kingdom

*Corresponding author: Ali M. Alshehri (e-mail: amsshehri@uqu.edu.sa).

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Abstract Environmental health in healthcare settings is essential for ensuring patient safety, protecting public health and promoting sustainable development-especially amid rising global concerns such as pandemics, climate change and antimicrobial resistance. The Kingdom of Saudi Arabia (KSA) has recognized the significance of environmental health as part of its healthcare policy framework and national development strategy under Vision 2030. This review explores how KSA has developed and implemented environmental health initiatives in its healthcare sector, particularly those governed by the Ministry of Health (MOH). The study analyzes publicly available policy documents from the MOH to assess the current scope of environmental health measures in medical facilities. These are then compared with international standards and guidelines, including those from the World Health Organization (WHO), the United States and the European Union. Key policy areas reviewed include waste management, energy efficiency, water conservation, indoor air quality, chemical safety, green building design, sustainable transportation and emergency preparedness. Findings reveal that while KSA has made substantial progress in advancing environmental health practices, notable policy gaps remain-particularly in areas such as recycling programs, green procurement and sustainability education for healthcare personnel. The review concludes by recommending policy enhancements to align more closely with global best practices. Strengthening environmental health measures in healthcare facilities can improve public health outcomes, reduce operational costs and support national sustainability goals.

Key Words Healthcare System, KSA, Environmental Health, Measures, Medical Facilities, Sustainability, Policy

INTRODUCTION

Environmental health within healthcare facilities plays a vital role in safeguarding patient safety, protecting healthcare workers and promoting public health. It is also an essential pillar in addressing wider global challenges such as climate change, antimicrobial resistance and infectious disease outbreaks. These environmental factors are directly linked to several Sustainable Development Goals (SDGs), including those related to health, water, sanitation and hygiene (WASH) [1].

The healthcare sector in the Kingdom of Saudi Arabia (KSA) is among the largest in the region and operates under a comprehensive three-tiered health policy framework. This includes a national policy that serves the population at large, supported by specialized policies developed by the Ministry of Health (MOH) to provide both curative and preventive services. Although environmental health concerns were first acknowledged in the 1970s through Saudi Arabia's inaugural national health policy, significant policy efforts to manage these issues systematically have emerged only in more recent years [2].

Urbanization, industrial expansion and increasing demand for healthcare services have introduced complex environmental challenges in KSA. These include high levels of energy and water consumption, medical and hazardous waste generation, poor indoor air quality and the widespread use of chemicals and pharmaceuticals. Addressing these challenges is essential to ensuring safe and sustainable healthcare delivery. As part of the broader Saudi Vision 2030, the MOH introduced the Environmental Health Policy for Healthcare Facilities in 2021, signaling a more structured and coordinated approach toward integrating environmental sustainability within the health sector [2,3].

This study aims to evaluate the current environmental health policies in KSA's healthcare facilities based on publicly available documents from the Ministry of Health.

These policies are compared with global standards and guidelines established by the World Health Organization (WHO), the United States [4-8] and the European Union [9-11]. The comparison focuses on identifying key policy areas, assessing their alignment with international best practices and pinpointing gaps where KSA can further enhance its environmental performance in healthcare settings.

The analysis highlights the critical importance of developing robust policies across several environmental domains-including waste management, energy efficiency, water conservation, air quality, chemical safety, green building standards, transportation, emergency preparedness and community engagement. A comprehensive environmental health policy not only improves the resilience and efficiency of healthcare systems but also promotes the health and well-being of patients, healthcare workers and surrounding communities [3].

The findings of this review offer targeted recommendations to support the MOH in strengthening environmental sustainability measures. These include expanding recycling programs, integrating lifecycle assessments into hospital operations, adopting green procurement practices and developing structured monitoring and evaluation frameworks. Ultimately, this work aims to contribute to the continued advancement of Saudi Arabia's health system in line with both national development priorities and global environmental health standards.

Environmental Health Policy of Healthcare in the United States (USA)

The healthcare sector in the United States plays a significant role in the nation's environmental impact, contributing approximately 4.6% of global greenhouse gas emissions and 8.5% of total U.S. national emissions [4]. Healthcare facilities in the U.S. generate an estimated 4 to 6 million tons of waste annually, including general, medical and hazardous waste. Notably, about 25% of this waste is classified as hazardous, posing serious environmental and public health risks if not managed appropriately [5,6].

The United States has developed a comprehensive and multi-tiered environmental health policy framework that governs healthcare facilities at federal, state and local levels. These policies address a range of environmental domains, including waste disposal, air and water quality, chemical safety, occupational health and sustainable infrastructure. The key components of this framework are outlined below:

Regulatory Framework

At the federal level, the U.S. Environmental Protection Agency (EPA) serves as the principal body responsible for environmental oversight. The EPA establishes and enforces regulations related to air and water quality, hazardous waste management and other environmental concerns that directly impact healthcare institutions.

Resource Conservation and Recovery Act (RCRA)

The RCRA is a cornerstone piece of environmental legislation that governs the management of hazardous waste. Under this act, healthcare facilities are legally obligated to implement protocols for the safe handling, storage, transportation and disposal of hazardous substances, including medical waste, pharmaceuticals and chemical agents.

Clean Air Act (CAA)

The CAA sets national standards for air quality, with specific regulations that apply to emissions from boilers, incinerators and other hospital-based pollution sources. Healthcare facilities must comply with these regulations to limit airborne contaminants and safeguard both environmental and human health.

Clean Water Act (CWA)

The CWA mandates standards for the protection of surface waters. It requires healthcare facilities to implement wastewater treatment, stormwater management and pollution control practices to reduce their environmental impact and comply with national water quality objectives.

Occupational Safety and Health Administration (OSHA)

The OSHA provides guidelines to maintain safe and healthy working conditions for healthcare personnel. These include controls for chemical exposure, infectious agents, biological hazards and ergonomic risks, making OSHA integral to the intersection of environmental and occupational health in medical environments.

Green Building and LEED Certification

The U.S. Green Building Council **promotes** Leadership in Energy and Environmental Design (LEED) certification, which is widely adopted by healthcare institutions to enhance energy efficiency, reduce water consumption and improve indoor environmental quality. Many U.S. hospitals pursue LEED certification to demonstrate their commitment to environmental sustainability.

Healthcare Sustainability Programs

Numerous healthcare organizations in the U.S. have developed internal environmental health policies and sustainability programs. These initiatives often focus on waste reduction, energy conservation, green procurement and community engagement. By doing so, they contribute to a lower environmental footprint and promote long-term operational efficiency.

State and Local Regulations

In addition to federal laws, U.S. healthcare facilities must comply with state and local environmental health regulations**,** which may vary widely across jurisdictions.

These can include specific rules for waste segregation, emissions standards, water discharge permits and facility inspections [7].

Public Health Preparedness

Environmental health policy in the U.S. also supports public health emergency preparedness and disaster response planning**.** Healthcare facilities are required to develop and maintain plans that ensure continuity of care during pandemics, natural disasters, or other emergencies, including protocols for infection control, medical waste management and facility resilience**.**

In conclusion, the environmental health policy landscape in the United States is characterized by a complex and layered regulatory structure. Compliance with federal, state and local regulations is essential for healthcare facilities to fulfill their responsibilities in protecting public health, mitigating environmental harm and promoting sustainability in healthcare operations [8].

Environmental Health Measures of Healthcare in the European Union (EU)

Healthcare facilities across the European Union (EU) are subject to a comprehensive and evolving framework of environmental health policies designed to safeguard public health, protect the environment and promote sustainable development. The scale of healthcare-related waste in the EU is substantial, with hospitals generating an estimated 6 million tons of waste annually, of which approximately 15% is classified as hazardous [9].

The EU establishes common environmental standards through legally binding directives and regulations that all member states are required to implement. A core example of this framework is the European Waste Framework Directive (EUWFD)**,** which outlines protocols for the safe disposal and treatment of medical waste across EU countries [10]. These regulations aim to harmonize environmental health practices within healthcare systems while allowing for national flexibility in implementation.

Key components of the EU's environmental health policy framework include the following:

EU Environmental Legislation

The EU has enacted a broad range of environmental laws that directly impact healthcare operations. These laws cover waste management, water and air quality, chemical safety and Environmental Impact Assessments (EIA). Healthcare facilities are mandated to comply with these legal requirements to ensure a high level of protection for human health and environmental integrity.

Waste Management

The EU Waste Framework Directive (EUWFD) mandates the proper handling of waste, with a particular emphasis on hazardous medical waste. Facilities are required to adopt safe segregation, storage, treatment and disposal procedures that minimize environmental risks. The directive also encourages waste minimization, recycling and material reuse as part of a broader circular economy approach.

Water Quality

Healthcare facilities must comply with EU regulations on surface and groundwater protection, especially concerning wastewater discharge and chemical contamination. The EUWFD supports integrated water resource management and sets minimum standards for pollution control and monitoring to safeguard water systems across member states.

Air Quality

The EU has established air quality regulations to control emissions of Particulate Matter (PM), Nitrogen Dioxide (NO_2) and sulfur dioxide (SO_2). Healthcare facilities are expected to limit emissions from boilers, incinerators and vehicular transport. These measures contribute to cleaner air within healthcare environments and surrounding communities, thereby reducing respiratory and cardiovascular risks.

Chemical Management

The EU implements the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation to oversee the manufacture, import and use of chemical substances. Healthcare facilities must comply with REACH to ensure safe handling, storage and disposal of chemicals used in cleaning, disinfection, laboratory work and infection control.

Green Healthcare Initiatives

The EU supports numerous sustainability initiatives within the healthcare sector. Programs such as the Sustainable Healthcare Coalition and the European Green Deal promote energy efficiency, green procurement and waste reduction. These initiatives encourage healthcare organizations to adopt environmentally responsible practices and reduce their carbon footprint.

Healthcare Infrastructure and Investment

Environmental standards also apply to healthcare infrastructure projects funded by the Cohesion Fund and the European Regional Development Fund (ERDF). These programs finance the construction, renovation and modernization of hospitals and healthcare facilities, requiring full compliance with Environmental Health Assessment (EHA) criteria and other sustainability benchmarks.

Cross-Border Cooperation

The EU actively promotes cross-national collaboration on environmental health issues. Mechanisms for knowledge sharing, technical assistance and joint policy development enable member states to coordinate their efforts and advance sustainable healthcare practices across borders.

In summary, environmental health policy in the European Union is underpinned by a strong commitment to public health protection, environmental preservation and sustainable development. Healthcare facilities are key players in achieving these goals and are expected to

comply with rigorous environmental regulations and adopt best practices in environmental management [11].

WHO Guidelines on Environmental Health Measures in Medical Care

The World Health Organization (WHO) provides comprehensive guidance on essential environmental health standards for healthcare facilities, particularly in the context of ensuring patient safety, infection prevention and equitable access to safe healthcare services. These standards serve as a global benchmark, especially for low- and middle-income countries and cover key infrastructural and operational areas within medical care environments [12].

The following are the primary domains outlined by WHO for maintaining environmental health in healthcare facilities:

- **Water Quantity and Availability:** Healthcare facilities are required to provide an adequate and reliable supply of water to meet daily operational and clinical needs. This includes water for drinking, food preparation, hand hygiene, patient care, cleaning of surfaces, medical procedures and laundry. The uninterrupted availability of water is fundamental to maintaining hygiene standards and preventing the spread of infections
- **Water Access and Infrastructure:** Facilities must ensure that water is easily accessible at all critical points of care. This includes having appropriately located water collection points, handwashing stations and plumbing systems that allow for safe and efficient water use across all service areas such as wards, kitchens, bathrooms and laboratories
- **Excreta Disposal:** Sanitary systems must include adequate, accessible and functional toilets for all healthcare facility users-patients, staff and visitors. Proper excreta disposal is essential to preventing fecal-oral transmission of diseases and maintaining a hygienic care environment
- **Wastewater Management:** Healthcare facilities should implement systems to ensure that wastewater is safely collected, treated and disposed of to prevent contamination of water sources, reduce disease transmission and comply with environmental regulations
- **Healthcare Waste Management:** Healthcare waste-including sharps, infectious materials and chemical waste-must be properly segregated, collected, transported, treated and safely disposed of. This process is critical to reducing risks to healthcare workers, patients and the surrounding environment
- **Cleaning and Laundry Services:** Regular cleaning of floors, surfaces, equipment and linens is essential for infection prevention and maintaining hygienic conditions. Proper laundry handling and disinfection also ensure the safety of patients and staff
- **Food Storage and Preparation:** Food provided to patients, caregivers and staff must be safely stored, handled and prepared to prevent foodborne illnesses. This includes maintaining appropriate temperatures, cleanliness of food preparation areas and use of hygienic utensils and water
- **Building Design, Construction and Management:** Healthcare facilities should be designed, constructed and maintained to support infection prevention, patient comfort and energy efficiency. This includes proper ventilation, lighting, temperature control and durable, easy-to-clean materials used in walls, floors and surfaces
- **Control of Vector-Borne Diseases:** Facilities should implement environmental control measures to prevent infestations of vectors**,** such as mosquitoes, rodents and flies, which can transmit diseases. These include structural barriers, pest control programs and removal of breeding grounds
- **Information, Education and Hygiene Promotion:** Educating healthcare workers, patients and visitors about proper hygiene practices and the correct use of water, sanitation and waste facilities is a core part of WHO guidelines. Effective information and hygiene promotion campaigns help foster a culture of safety and shared responsibility in healthcare environments

Overall, the WHO's framework emphasizes a holistic and preventive approach to environmental health within healthcare facilities. Implementing these standards supports infection control, occupational safety and environmental sustainability, particularly in settings with limited resources [12].

Background of Environmental Health Measures in Medical Care in KSA

The Kingdom of Saudi Arabia (KSA), the largest country in the Middle East, is undergoing rapid demographic, economic and infrastructural transformation aligned with Saudi Vision 2030. As the country modernizes and expands its development agenda, ensuring the health and safety of its population remains a national priority. In this context, environmental and occupational health hazards pose significant challenges, particularly within the healthcare sector, which is a major consumer of natural resources, energy and materials and a significant generator of both hazardous and non-hazardous waste [2].

For instance, government hospitals in KSA annually dispose of vast quantities of waste, including approximately 27,000 tons of paper, 15,000 tons of plastic, 10,000 tons of food waste, 8,000 tons of glass and 7,000 tons of metals. These materials are typically sent to landfills without proper recycling or resource recovery [13,14]. The absence of integrated waste management systems highlights the need for robust environmental health policies, which can play a pivotal role in reducing environmental burdens and improving public health outcomes [6].

A study titled "Sustainability of Quality Improvement Initiatives within Saudi Ministry of Health Hospitals: An Institutional Overview" [15,16] outlines the country's strategic alignment of its healthcare system with Sustainable

Development Goal (SDG) 3: Good Health and Well-being. It identifies several focus areas critical to achieving this goal:

- Maternal and Child Health Improvements
- Communicable Disease Control
- Non-Communicable Disease (NCD) Management
- Universal Health Coverage (UHC)
- Environmental Health Progress
- Immunization and Health Security
- Healthcare Workforce Expansion
- Data and Surveillance Enhancements
- Healthcare Privatization

This broad national commitment has already contributed to a measurable increase in life expectancy and improved public health indicators.

As part of these reforms, the Ministry of Health (MOH) formally issued the Environmental Health Policy for Healthcare Facilities in November 2021, reinforcing its commitment to environmentally sustainable healthcare practices [2]. The policy supports national response plans and outlines the responsibilities of healthcare institutions in mitigating environmental health risks. It incorporates a strategic vision, mission, objectives, policy statements and the designation of key stakeholders responsible for implementation and compliance.

To operationalize this policy, the MOH released a Policy and Procedure Manual for Environmental Health Programs in Health Facilities [16]. This manual provides detailed guidelines in the following priority areas:

- Water Quality Monitoring Policy and Procedures
- Indoor Air Quality Policy and Procedures in Healthcare Facilities
- Waste Disposal Monitoring Policy and Procedures
- Kitchen Hygiene Requirements Policy and Procedures
- Building Demolition, Construction, Renovation and Restoration Policy and Procedures
- Pest Control Policy and Procedures
- Employee Housing Health Requirements Policy and Procedures
- Laundry Health Requirements Policy and Procedures
- Investment Site Health Requirements Monitoring Policy and Procedures
- Environmental Awareness Policy and Procedures in Healthcare Facilities

These policies serve as a foundation for building sustainable, resilient and health-promoting healthcare environments throughout the Kingdom.

Current Environmental Health Issues in KSA

Despite recent progress, Saudi Arabia continues to face a range of pressing environmental health issues. These include:

- Groundwater contamination
- High emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x)
- Waste from cement production
- Land degradation and desertification

These challenges are largely driven by rapid urbanization, population growth, economic development and increasing demand for water, energy and infrastructure.

Nonetheless, KSA has demonstrated strong advocacy in addressing environmental challenges and climate change. Leveraging its natural resource base and global influence in energy policy, the country has launched several national and international initiatives aimed at reducing emissions and strengthening environmental stewardship, including:

- **Joining the Global Ocean Alliance:** In October 2021, Crown Prince Mohammed bin Salman announced KSA's participation in this global initiative, which aims to protect 30% of the world's oceans by 2030 through the designation of marine protected areas. Additionally, KSA launched the Ocean Exploration Foundation to advance oceanic research and marine conservation
- **Reducing Methane Emissions:** As a signatory to the Global Methane Pledge, KSA has committed to reducing global methane emissions by one-third by 2030, reflecting its dedication to a cleaner and more sustainable future
- **Promoting Climate-Friendly Sports:** KSA participates in the UN's Sports for Climate Action Initiative, which encourages sustainable practices within the global sports sector under the umbrella of the Saudi Green Initiative
- **Saudi Green Initiative:** This national campaign encourages individuals and institutions to take environmental action through tree planting, emission reductions and sustainable land management
- **Middle East Green Initiative:** A regional platform led by KSA to foster climate cooperation and mobilize joint investments in environmental sustainability solutions across the Middle East

Local Environmental Projects and Campaigns

KSA has launched several domestic environmental campaigns as part of its broader environmental health strategy:

- **Green Riyadh Project:** Initiated by the Royal Commission for Riyadh City, this afforestation project aims to plant over 7.5 million trees in the capital to improve air quality, reduce urban heat and promote healthier lifestyles-fully aligned with Vision 2030 goals
- **Environment Week:** Held annually under the supervision of the Council of Ministers, this nationwide awareness campaign promotes resource conservation and sustainability through public education and sector-wide engagement
- **Vegetation and Desertification Control:** Led by the National Centre for Vegetation Cover Development and Combating Desertification, this initiative

addresses land degradation and biodiversity loss caused by both human and natural factors

- **Soil Pollution Mitigation:** The newly established Soil Quality Department under the National Centre of Meteorology monitors soil health, enforces pollution control and promotes best practices in land use and waste management
- **Water Pollution Reduction:** With water scarcity emerging as a serious challenge, especially due to groundwater overuse and agricultural demand, KSA is conducting comprehensive sector assessments to enhance water governance and introduce sustainable water management solutions
- **Air Pollution Control:** The General Authority for Meteorology and Environmental Protection is actively enforcing air quality standards and identifying high-pollution zones. The agency implements targeted strategies to reduce industrial and vehicular emissions that threaten both public health and environmental integrity [16]

CONCLUSIONS

The Kingdom of Saudi Arabia has taken commendable steps toward integrating environmental health measures within its healthcare system, aligning with broader national sustainability goals under Vision 2030. The Ministry of Health (MOH) has demonstrated significant progress through the development of environmental policies, implementation of regulatory frameworks and participation in national and global sustainability initiatives.

This review highlights that while substantial advancements have been made-particularly with the issuance of the 2021 Environmental Health Policy for Healthcare Facilities-there remain critical gaps and opportunities when comparing KSA's approach with international standards set by the World Health Organization (WHO), the United States and the European Union.

To further enhance environmental sustainability and public health outcomes in Saudi healthcare facilities, the following recommendations are proposed:

- **Introduce Comprehensive Recycling Programs:** Establish formal waste segregation and recycling policies across all healthcare institutions to reduce reliance on landfills and improve solid waste management systems
- **Integrate Life Cycle Assessments (LCA):** Apply LCA methodologies to evaluate the environmental impacts of healthcare operations-from procurement and construction to disposal. This approach will support evidence-based decision-making and resource optimization
- **Adopt Green Procurement Policies:** Develop a policy that prioritizes the purchase of environmentally friendly, energy-efficient and low-emission products. This would reduce the environmental footprint of healthcare services and encourage sustainable supply chains
- **Strengthen Monitoring and Evaluation Systems:** Implement regular audits, performance metrics and compliance monitoring to ensure environmental policies are effectively executed and improved over time
- **Promote Sustainability Education and Training:** Include environmental health and sustainability practices in training programs for healthcare workers and facility managers to foster a culture of environmental responsibility
- **Align More Closely with Global Best Practices:** Continue benchmarking MOH policies against evolving international guidelines to identify areas for policy expansion, particularly in energy efficiency**,** climate adaptation and emergency preparedness

In conclusion, while Saudi Arabia has laid a strong foundation for environmental health in the healthcare sector, continued investment in policy enhancement, capacity building and cross-sector collaboration is essential. These actions will not only support national objectives but also contribute to global efforts to create resilient, sustainable and health-promoting environments.

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